An Integrated Look at R&D Technologies Supporting Improved NAS Capacity and Security

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Agenda

- The Future of National Airspace System (NAS)
- NGATS Goals and Objectives
- Process:
  - The Technology Elements
  - Assess Impact on Total System Goals
  - Analyze and Test/Validate
- Results from the Joint Industry Analysis
- Conclusions

The Future of National Airspace System (NAS)

- Increasing demand
- Increasing cost of operation:
  - Service providers
    - Aging infrastructure
    - Human-centric
  - Air space users
- Airline financial pressure, bankruptcy
- Continued pressure of security costs
- Decreasing funds for NAS R&D

➜ Must get the highest return for R&D effort

Avg Monthly Operations - Centers

12 months ending March

Source: FAA OPSNET data 4/05
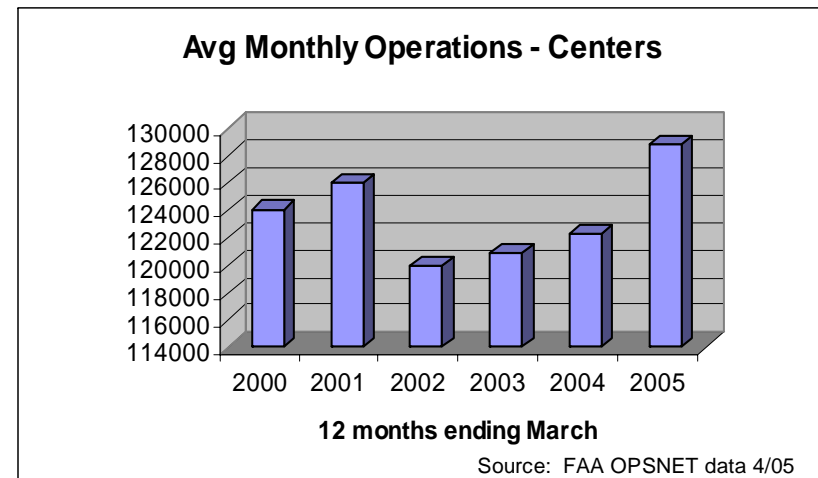
- *Price of jet fuel has doubled since 2001*
-- John Heimlich, VP/Chief Economist, ATA
- *"U.S. airlines lost … $10 billion in 2004."*
  "Five large U.S. airlines are fighting to emerge from bankruptcy…"
--James C May, President/CEO ATA 3/10/05

Congressional Direction and Study Structure

Study Objectives from Congressional Direction

- Develop a five-year research plan for aeronautics Research & Technology

- Include air traffic management

- Take significant near-term steps toward making the investments required to restore the US to technological superiority in aviation and aeronautics

Study Structure

- Airspace Systems

- Aviation Safety and Security

- Hypersonic

- Rotorcraft

- Subsonic

- Supersonic

- Workforce and Education

Airspace Systems and Aviation Security

- Study guidelines for all R&D areas
  - Recommend
    - Additional funding required
    - Technology maturation schedules
    - Specific demonstrations of the resulting technologies
  - Industry/academia-wide:
    - No company, organization or product line shall dominate
- Team
  - CSC (prime), Boeing, Lockheed-Martin, Raytheon
  - Consultants: Gary Church/Mike Harrision (Aviation Management), Jerry Thompson Assoc, Marty Pozesky (MTP Assoc), Dr. Jerry Creedon (Old Dominion U), Dr Phil Smith (Ohio State U), Dr. John Hansman (MIT)

Goals and Objectives
Next Generation Air Transportation System (NGATS)

Retain U.S. Leadership in Global Aviation
- Retain our role as the world leader in aviation
- Reduce costs for air transportation
- Enable services tailored to traveler and shipper needs
- Encourage performance-based,harmonized global standards for U.S. products and services to keep new and existing markets open

Protect the Environment
- Reduce noise, emissions, and fuel consumption
- Balance aviation's environmental impact with other societal objectives

Expand Capacity
- Satisfy future growth in demand (up to 3 times current levels) and operational diversity
- Reduce transit time and increase predictability (domestic curb-to-curb transit time cut by 30%)
- Minimize the impact of weather and other disruptions (95% on time)

Ensure our National Defense
- Provide for the common defense while minimizing civilian constraints
- Coordinate a national response to threats
- Ensure global access to civilian airspace

Ensure Safety
- Maintain aviation's record as the safest mode of transportation
- Improve the level of safety of the U.S. air transportation system
- Increase the safety of worldwide air transportation

Secure the Nation
- Mitigate new and varied threats
- Ensure security efficiently serves demand
- Tailor strategies to threats, balancing costs and privacy issues
- Ensure travel and shipper confidence in system security

Barriers to Achieving Goals

- Uncertainty in aircraft position versus planned position

- Imprecise (or lack of) knowledge of aircraft intent

- Inability to precisely control aircraft in accordance with planned trajectory

- Dynamic changes in the system: e.g., weather, demand peaks/congestion, outages

- Increased demand/utilization places greater pressure on safety and security performance
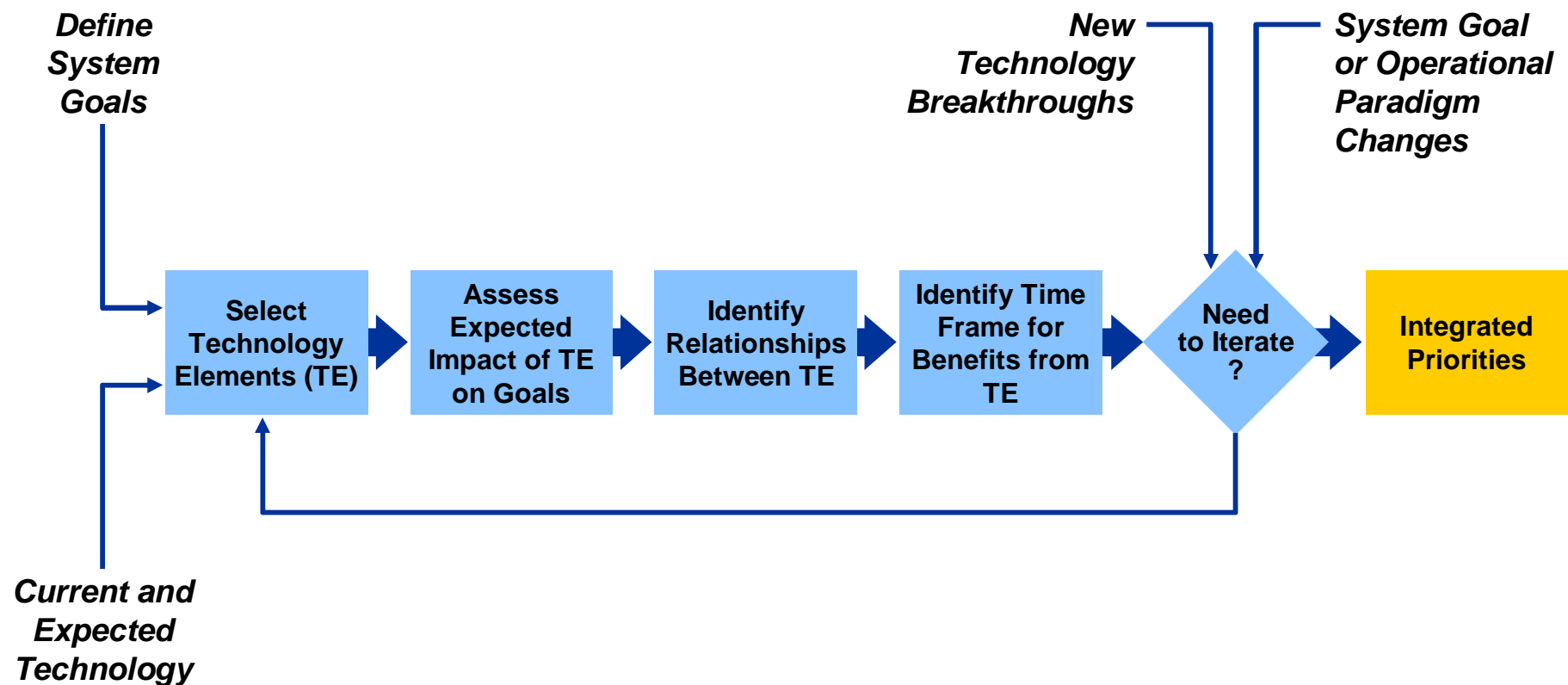
Technologies Expected to Help

- Improved knowledge of aircraft position and intent
- Improved RNP ability of aircraft
- Improved collaboration between users and service providers
- Improved system automation and resiliency
- Potentially significant changes to operational paradigm
  - Restructuring the airspace
  - Reallocation of separation responsibilities
- No single "magic bullet": require improvements in all of today's operational domains
  - Airport
  - Terminal
  - En Route and Oceanic
  - Traffic Flow Management

Assessing R&D Priorities Overview

Define System Goals

Current and Expected Technology

New Technology Breakthroughs

System Goal or Operational Paradigm Changes

Select Technology Elements (TE) → Assess Expected Impact of TE on Goals → Identify Relationships Between TE → Identify Time Frame for Benefits from TE → Need to Iterate ? → **Integrated Priorities**

Process: Select Technology Elements

Capacity Subsectors	Security Subsectors
• Strategic Airspace Usage • Efficient Flight Path Management • Airport and Surface Management • System-Wide Information Management	• NAS Security Infrastructure • Commercial Aircraft Security • Business and General Aviation Security

- Identify key technologies ("technology elements") that are expected to have impact in any Subsector

- Include all "enabling" technologies, that may not directly impact Goals, but may enable other technologies which do directly impact

- Attempt to "span the space" of anticipated new technologies that might impact any domain (airport, terminal, en route/oceanic, traffic flow management) within the time window being considered (completeness)

- Attempt to define technology elements as independently as possible (orthogonality)

Sample Principal Technology Elements

- Alternative ATM Paradigm
  - Eliminate Artificial Airspace Boundaries
  - Optimize Integrated Air vs Ground separation allocation
- Airport
  - Increasing Runway Utilization
  - Improve Surface Throughput
  - Increase All Weather Capacity at Airports
  - Metro Area Complex: New Concepts
- Terminal and En Route
  - Reduced Separation Standards
  - 4D Trajectories for Term and En Route
  - Improved VFR/IFR Operations with Electronic Flight Rules
  - CNS for ATM: bandwidth & accuracy of comm, 4D nav, new surveillance
  - En Route Operations — Tubes in Airspace
- Traffic Flow
  - Improved Aircraft Position Information for (Deterministic) System Wide Evaluation and Planning
  - Near Term probabilistic, region-wide effects of flow plan models
  - Multi-Facility Time-Based Metering
- Security Technology Elements
  - Aircraft vulnerabilities (current and future)
  - Conformance monitoring of aircraft

Sample Enabling Technology Elements

- Models to assess technology impacts on operations and cost/benefits
- Improved intent knowledge, including inbound international flights
- New information management system architecture
- Quality of Service data for NAS data
- Data link and position reporting system
- Highly reliable computer security technologies
- Technologies for pilot identification/verification for GA and commercial

Process: Assess Expected Impact

- Assess expected impact (Low/Medium/High) of each technology element on the Goals using the collective judgment of the team
- Assess Expected Timeframe for Benefits, considering
  - Maturity of technology element
  - Availability of required "enabling" technologies
  - Potential equipage timelines: users, service providers
- Examine relationships between technology elements
- "Enabling" technology elements inherit impact from the technologies they enable
- "Sum" (weighted) the overall impacts of each technology element

Process: Assess Technology Elements Versus Goals

Goal	Wt										
Retain our role as the world leader in aviation	9	H	H	M	H	H	H	M	H	H	H	M
Reduce costs for air transportation	7	H	M	H	H	H	H	H	H	H		M
Enable services tailored to traveler and shipper needs	7	H	H	M	M	M	H	M	H	H	H	M
Encourage performance-based, harmonized global standards for U.S. products and services to keep new and existing markets open.	7	H	M	M	M	H	H	M	H	M	H	M
Satisfy future growth in demand (up to 3 times current levels) and operational diversity	3	H	H	M	M	H	H	M	M	H	M	L
Reduce transit time and increase predictability (domestic curb-to-curb transit time cut by 30%)	9	H	H	M	M	H	H	M	M	H	M	M
Minimize the impact of weather and other disruptions (95% on time)	3	M	M				M				L	
Maintain aviation's record as the safest mode of transportation	3	H	M	M	M	M	H	M	M	M	M	M
Improve the level of safety of the U.S. air transportation system.	3	H	H	M	M	H	H	M	M	M	M	M
Increase the safety of worldwide air transportation	7	H	M	M	M	H	H	M	M	M	M	M
Reduce noise, emissions, and fuel consumption.	1											
Balance aviation's environmental impact with other societal objectives.	3	M	M									
Provide for the common defense while minimizing civilian constraints.	3	M	M	M		M	M	M	M	H	M	M
Coordinate a national response to threats	7	H	H	M	M	M	M	M	H	H	M	M
Ensure global access to civilian airspace	7	H	H	M	M	M	M	M	H	M	M	M
Mitigate new and varied threats	3	H	M	M	M	M	H	H	M	M	M	M
Ensure security efficiently serves demand .	7	H	H	M	M	H	H	M	H	M	M	M
Tailor strategies to threats, balancing costs and privacy issues.	7	H	H	M	M	H	H	H	M	M	M	M
Ensure travel and shipper confidence in system security.	7	H	H	M	M	H	H	H	H	H	M	M

Results from a Joint Industry Analysis

- ATM Goals assessed:
  - Capacity
  - Security
  - Cost Reductions for Service Providers
  - Cost Reduction for Users
- 20-year horizon considered
- 25 technology elements selected having medium or high impact to Capacity or to Security
- Near-term benefit deemed twice as beneficial as same benefit available only in far-term
- Weighted sum used to obtain overall prioritization
- Qualitative conclusions:
  - Many technology elements are inherently related
  - Achieved granularity in priority computations, but the complete set of technology elements is necessary to maximize ATM benefit

Conclusions

- Process worked well in helping evolve a highly subjective issue into a more structured, quantitative assessment process
- Key high priority technology elements were identified in the process
- Recommendations for future study
  - Develop high-level, macro-model to assess the overall system-wide impacts of the individual technologies for range of scenarios
  - Develop a process for assessing benefits versus costs for key technology elements
    - Who receives the benefit? All system stakeholders or only selected?
    - How are the costs allocated? Are there hidden costs?
    - How might we transition to such a cost/benefit-driven system?